

**REMARKS**

To advance the prosecution of this case, Applicants have set forth below a response to the Final Action issued in the earlier related application.

**I. The 35 U.S.C. 112, first paragraph rejection of Claims 1-22**

The Examiner indicates that Claims 1 –22 are rejected under 35 U.S.C. §112 because they fail to comply with the written description requirement.

More specifically the Examiner states that the range of “about 25% to about 90%” incorporated into the limitations of Claim 1 is new matter and that the specification provides support for the “degree of polymerization of ‘less than 90’ which is understood as 90 or less including monomers.” The Examiner further states that the specification contains no limitation of “25%” or “about 25%” and that the upper range of “about 90%” is also considered new matter, since “the term ‘about’ enables for amounts slightly higher than 90%, which is not supported by the specification.

In response thereto, Applicant refers the Examiner to the description appearing on page 5, lines 29-31 of the present application where it is stated that:

Under these controlled conditions, depolymerization of the polyamide reduces the average molecular weight of the polyamide from between about 10% to about 75%.

The amended claim contains a precisely equivalent restatement of this in a form that conforms more readily to the structure of the claim and thus does not include new matter. As stated in the amended claim, if the depolymerization conditions reduce the average molecular weight of the polyamide from between about 10% to about 75%, then the average molecular weight of the partially depolymerized polyamide will be between about 25% and about 90% of the initial polyamide average molecular weight. To use a concrete example, if a polyamide has an initial average molecular weight of 10,000 that is then reduced between about

10% and about 75%, the resulting partially depolymerized polyamide will have an average molecular weight of between about 2,500 (75% reduction) and 9,000 (10% reduction). An average molecular weight of 2,500 is 25% of the initial average molecular weight and an average molecular weight of 9,000 is 90% of the initial average molecular weight, as stated in the amended claim.

The Examiner also states that “Second recitation of the degree of polymerization enabled by the specification is 10-70%.” Applicant respectfully submits that a “degree of polymerization” of 10-70% is not found in the specification of the current application because degrees of polymerization are, by definition, not expressed as percentages. A clear distinction exists between what is claimed in the invention, viz., a “decrease [of] the *average molecular weight* of the depolymerized polyamide to [a percentage of] the initial *average molecular weight*,” [emphasis added] and the “degree of polymerization” that is referred to by the Examiner. Applicant respectfully submits that to those skilled in the art, *number average* degree of polymerization is defined as the average number of structural units per polymer chain. While a correlation exists between number average degree of polymerization and average molecular weight, the terms are not interchangeable. Applicant has been careful regarding the use of the term “degree of polymerization” so that it does not occur in the claims.

**II. The 35 U.S.C. 102(a) rejection of Claims 1, 4, 6, 8, 9, 13, and 17-21 as being anticipated by Booij (US 6,020,486)**

For reasons of record, the Examiner rejected the claims identified above under 35 U.S.C. 102(a) as anticipated by Booij.

The present invention discloses a process for recovering polyamide material from post-industrial and post-consumer products that involves partially depolymerizing the polyamide from about 25% to about 90% of its initial average molecular weight. Booij discloses a process for the depolymerization of polyamides. Example I states that the “[t]he degree of conversion to monomeric components of polyamide-6 was 11.5%.” Examples II-VIII show a degree of conversion to

caprolactam of 5 to 37 percent (Tables I and II). Each of Examples II-VIII requires the use of a catalyst (phosphoric acid in the case of Examples II-V; phosphorous acid in the case of Example VI; sodium glycolate in the case of Examples VII and VIII). No catalyst is used in the present invention.

Example I of Booij ("Example I") does not use a catalyst, but it is also outside the scope of the present invention. According to currently amended claim 1, the average molecular weight of the partially depolymerized polyamide is between about 25% and about 90% of the initial average molecular weight. Example I states a "degree of conversion to *monomeric components* of polyamide-6" [emphasis added] of 11.5%. No disclosure is made of the reduction in *average molecular weight* of the polymer of Booij. There is a significant difference between the two concepts. As is well known to those skilled in the art of condensation polymerization, a correlation exists between the amount of monomers present in such a mixture and the average molecular weight of polymer present. Condensation polymers such as polyamides are formed by a step polymerization mechanism that leads to a statistical distribution of polymer chain lengths. When a significant concentration of monomers is present, the average degree of polymerization (and hence molecular weight) will be relatively low. Commercial polyamides have an average degree of polymerization (and hence molecular weight) that is sufficiently high such that there are very few monomers present in the distribution of polymer chain lengths. (This situation is somewhat complicated in the case of polyamides derived from lactams, such as polyamide 6, which is used in Example I, as there will always be several weight percent lactam present unless the polyamide is extracted to remove the lactam.)

The nature of the statistical distribution of polymer chain lengths in condensation polymers and the correlation between the amount of monomers present and the average molecular weight is well understood in the art. In order for Booij to have converted post-consumer waste polymer such that 11.5% monomeric components were present, it would be clear to one skilled in the art and knowledgeable in the statistical behavior of condensation polymerization that the average molecular weight of Booij's polymer was reduced to significantly less than 25% of the initial average molecular weight.

**III. The 35 U.S.C. 102(a) rejection of Claims 1-3, 11, 12, and 21 as being anticipated by DD 264,119**

The Examiner rejected Claims identified above under 35 U.S.C. 102(a) as being anticipated by DD 264,119, cited as disclosing a process of recovering polyamide by dissolving it in a solvent, partially depolymerizing it, and then forming from the recovered oligomers a new polyamide. The Examiner states that the polyamide to be recovered in '119 is polyamide-6, otherwise known as nylon-6, and that polyamide of '119 is dissolved in caprolactum, which also serves as depolymerization catalyst at the same time.

The disclosure in '119 does not support the authors' contention that they are depolymerizing the PA 6 used. This is because they are dissolving the PA 6 in caprolactam, the monomer used to make PA 6, and they are then subjecting the mixture to the sorts of conditions used to *polymerize* caprolactam to PA 6. Thus, though they see a reduction in the average molecular weight of the PA 6 they isolate from the reactor relative to the PA 6 that was initially fed to the reactor, they haven't shown that that reduction was caused by the depolymerization of the original PA 6 and not the polymerization of caprolactam itself to give oligomers or low MW polymers whose presence was lowering the overall detected average degree of polymerization of the resulting isolated polymer. The authors of '119 do not provide a mass balance that shows they got back at least as much caprolactam as they added to the reactor, as would be necessary if a true depolymerization were taking place.

**IV. The 35 U.S.C. 103(a) rejection of Claims 2, 3, 5, 7, 10 and 12 as unpatentable over Booi in view of Wiltzer (US 5,962,538)**

For reasons of record, the Examiner rejected the claims identified above under 35 U.S.C. 103(a) as unpatentable over Booi in view of Wiltzer.

Booij describes a process for generating significant quantities of monomers by depolymerizing polyamides, while the present invention relates to the partial depolymerization of polyamides in a process that yields negligible amounts of monomers. Further, Applicant's other observations relative to Booij as set forth in Section II above are incorporated by reference as if fully set forth herein.

The repolymerization step of the process of the present invention is done on the partially depolymerized polyamides that contain negligible amounts of monomers. The process described in Wiltzer involves a method of polymerizing recycled caprolactam with "fresh"  $\epsilon$ -caprolactam to produce polyamide 6. Neither Booij nor Wiltzer describe the repolymerization of partially depolymerized polyamides; rather they focus on generating and polymerizing monomers. Thus it would not have been possible to apply their teachings to the partial depolymerization-repolymerization process of the present invention.

**V. The 35 U.S.C. 103(a) rejection of Claims 4-10, 13-15, and 17-21 as unpatentable over DD 264,119 in view of Booij (US 6,020,486)**

The Examiner rejected the claims identified above under 35 U.S.C. 103(a) as unpatentable over '119 in view of Booij. The Examiner states that use of solvents such as lower alcohols of Booij would result in successful depolymerization of polyamide waste from carpets and that filtration of the precipitated polymer is a method already known as indicated by prior art in Booij. The Examiner further states that "utilizing solvents and separation techniques of Booij would also result in a process capable of partial depolymerization of polyamide, since the solvents of Booij are capable of dissolving polyamide of DD 264,119."

Applicant's comments as above regarding Booij and DD 264,119 are incorporated by reference as if fully set forth herein. The limitations of each of these references and the distinctions between them makes them not attractive to those having skill in the art to attempt to combine them in the manner suggested by the Examiner.

**VI. The 35 U.S.C. 103(a) rejection of Claim 11 as unpatentable over Booij (US 6,020,486) in view of Wiltzer (US 5,962,538) as applied to Claims 1-9, 12, 13, and 17-21 above, and further in view of Alsop (US 6,069,228)**

For reasons of record, the Examiner rejected Claim 11 under 35 U.S.C. 103(a) as unpatentable over Booij, in view of Wiltzer as applied to claims identified above, and further in view of Alsop.

As has been demonstrated in Section IV above, the processes and methods disclosed by Booij and Wiltzer apply to the depolymerization of polyamides to monomers and the subsequent repolymerization of these monomers. Further, Applicant's other observations relative to Booij as set forth in Section II above and to Wiltzer as set forth in Section IV above are incorporated by reference as if fully set forth herein. Therefore it would not have been possible to combine these teachings with those of Alsop, which describes the preparation and further polymerization of polyamide prepolymers, to reach the present invention.

**VII. The 35 U.S.C. 103(a) rejection of Claims 14-16 as unpatentable over Booij in view of Moran (US 5,280,105)**

For reasons of record, the Examiner rejected Claims 14-16 under 35 U.S.C. 103(a) as unpatentable over Booij in view of Moran.

As detailed earlier, Booij describes a process for generating significant quantities of monomers by depolymerizing polyamides, while the present invention relates to the partial depolymerization of polyamides in a process that yields negligible amounts of monomers. Applicant's other observations relative to Booij as set forth in Section II above are incorporated by reference as if fully set forth herein.

Moran discloses a method of removing solid nylon 6 from a mixture of nylon 6 and nylon 66 without depolymerization. Thus, it would not have been possible to combine Moran with Booij to arrive at the present invention as there is no motivation to look at filtration techniques disclosed in references not directed to

depolymerization. Additionally, as noted by the Examiner, Moran discloses the use of a "glass fritted filter funnel," but does not indicate that glass fibers would be effective for filtration. As is well-known in the art, fritted filter funnels are generally more effective at trapping solids than glass fibers are. Thus, one would have no motivation to extrapolate from Moran's use of a fritted filter funnel to the glass fibers, the preferred embodiment used in the present invention.

**VIII. The 35 U.S.C. 103(a) rejection of Claim 16 as unpatentable over DD 264,119 in view of Booij (US 6,020,486) as applied to Claims 1-15, and 17-21 above, and further in view of Moran (US 5, 280, 105)**

Applicant respectfully submits that given the various teachings of each of DD 264,119, Booij and Moran as explained above (incorporated by reference as if fully set forth herein), the limitations of each of these references makes them not attractive to those having skill in the art to attempt to combine them in the manner suggested by the Examiner. That is, to combine DD 264,119 with its lack of teachings on depolymerization with Booij with its required catalyst and with Moran again not involving depolymerization, is not an approach suggested by these references and even if followed is unclear as to the result.

**IX. The 35 U.S.C. 103(a) rejection of Claim 22 as unpatentable over Booij (US 6, 020,486) in view of Yang (US 6,036,726)**

For reasons of record, the Examiner rejected Claim 22 under 35 U.S.C. 103(a) as unpatentable over Booij in view of Yang.

As detailed earlier, Booij describes a process for generating significant quantities of monomers by depolymerizing polyamides, while the present invention relates to the partial depolymerization of polyamides in a process that yields negligible amounts of monomers. Applicant's other observations relative to Booij as set forth in Section II above are incorporated by reference as if fully set forth herein.

Yang discloses a process for removing colorants under which "the molecular weight of the polymer is not dramatically reduced" and "the polymer can be reused without the expense of repolymerization" (col. 8, lines 59-61). Thus, it would not have been possible to combine Yang with Booij to arrive at the present invention since neither depolymerization nor repolymerization is the focus of Yang.

**X. The 35 U.S.C. 103(a) rejection of Claim 22 as unpatentable over DD 264,119 in view of Yang (US 6,036,726)**

The Examiner rejected Claim 22 under 35 U.S.C. 103(a) as unpatentable over '119 in view of Yang. Applicant respectfully submits that the strong teachings of Yang reflected in Section IX above regarding its lack of focus on depolymerization or repolymerization make Yang equally not suited to being combined with DD 264,119 (and difficulties associated with DD 119 are also captured throughout the preceding remarks and are incorporated by reference as if set forth herein).

**XI. Conclusion**

For the foregoing reasons, Applicant submits that pending Claims 1-22 as amended are in condition for allowance versus the cited prior art

Respectfully submitted,



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